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School Asthma Care During COVID-19: What We Have Learned and What We Are Learning

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The focus of this article is to review school asthma care during coronavirus disease 2019 (COVID-19). Asthma is listed as a risk factor in some guidelines, although children with asthma appear to not be at increased risk of severe respiratory outcomes compared with children without asthma during the pandemic. Differentiating COVID-19 from allergic disease is very difficult in the school-aged children. For school management, there is firm evidence that masks do not exacerbate underlying lung conditions including asthma, and evidence to date supports that children with asthma can learn in-person at school because they do not appear to be at increased risk of COVID-19 morbidity or mortality. For children and adolescents, the COVID-19 vaccine has been demonstrated to be safe and well tolerated. School asthma management includes remaining on prescribed asthma medications. Asthma management, as with management of all pediatric conditions, must also factor in the impact of adverse social determinants and health disparities. Broadly, the pandemic has also served as a call to resource stewardship and innovation and allowed practitioners to consider how this may impact asthma care moving forward. © **2021 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2022;10:453-9)**

Key words: COVID-19*;* Asthma*;* Asthma therapeutics

INTRODUCTION

As of October 12, 2021, there have been over 238 million cases of coronavirus disease 2019 (COVID-19) worldwide, and over 4.8 million deaths.[1] In the United States, there have been more than 44 million cases and more than 715,000 deaths to date. Although the impact of the global pandemic has been mitigated with mass international vaccination efforts, it remains in the forefront on the mind of clinicians and families across the globe.

The pandemic has had a broad direct and indirect impact on children and their families. Whereas children infected with COVID-19 have a better prognosis than adults[2] and severe illness is less common,[3] severe illness when it occurs can be significant among those admitted to hospital and is predicated by preexisting comorbidities.[3] Data from the U.S. Centers for Disease Control and Prevention (CDC) has demonstrated that among the 96% of COVID-19 cases in which age was known, only 8.1% was among children younger than 18 years of age.[4] However, morbidity can be high and there are racial and ethnic disparities in outcomes.[5]

Although, in general, preschool- and school-aged children were at low risk of a direct impact of COVID-19 during the early waves of the pandemic,[6] an increase in variants of concern has resulted in the possibility of increasing transmissibility rates to children as well as the possibility of increased morbidity and mortality.[7] In addition, there is a rising recognition of other long-term complications being seen in the pediatric population—such as long COVID and multisystem inflammatory syndrome in children.[8,9]

With the fall return to school, for families of children with asthma, as with families overall, there is significant concern about ensuring the safety and security of children. Specifically, there are concerns related to the risk that asthma poses to COVID-19 severity, and how broad public health measures impact children with asthma at school. Few articles have synthesized an approach to school-based management among children with underlying conditions such as asthma, who may be at real—or perceived—increased risk. As a result, the focus of this article is to review school asthma care during the pandemic (Figure 1).

IMPACT OF ASTHMA ON COVID-19 OUTCOMES IN CHILDREN

A major factor in parental comfort with school attendance among children with asthma is their risk should they acquire COVID-19 and, in particular, whether asthma places children at higher risk of severe COVID-19 outcomes. There are specific underlying chronic medical conditions that increase the risk of severe COVID-19 outcomes in children. These include obesity,

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Abbreviations used
CDC- U.S. Centers for Disease Control and Prevention
COVID-19- Coronavirus disease 2019
ED- Emergency department
ICS- Inhaled corticosteroids
SARS-CoV-2- Severe acute respiratory syndrome coronavirus 2

chronic lung disease, neurodevelopmental disorders and epilepsy, immunodeficiency, and older-aged children.[10]

Whereas children with chronic lung disease are more likely to have severe or critical COVID-19, asthma has in general been an exception.[4,6,11-16] In general, those with asthma are thought to be at low risk of COVID-19's severe outcomes.[17] A national prospective Canadian study of 264 children admitted to hospital with COVID-19 infection found that, although 39.3% of those children admitted had at least 1 comorbidity including chronic lung disease, asthma was an exception.[6] A retrospective review of COVID-19 infection among children with asthma noted no increased COVID-19 severity independent of asthma severity and control over the year prior to the pandemic.[13] In addition, a systematic review on asthma and COVID-19 in children noted no significant data that childhood asthma constitutes a risk factor for COVID-19 infection or severity.[18] Although 1 report from the CDC found 11.5% of children with data had "chronic lung diseases including asthma" and 1 tertiary hospital reported asthma in 23.9% of children hospitalized for COVID-19,[19] other studies have suggested perhaps even a protective risk associated with atopy.[20,21] It has been demonstrated that downregulation of angiotensin-converting enzyme-2 expression on target cells (including in the lungs) due to T helper 2 cytokines may actually reduce the risk of COVID-19 infection in atopic children.[20,21]

There is a concern that a rise in asthma exacerbations will be seen over the fall and spring this year; however, this was not noted during the first 3 waves of the pandemic.[13,22-26] A study on asthma-related emergency department (ED) utilization in a high-volume U.S. children's hospital found, for the year 2020, a dramatic reduction in asthma-related ED use (compared with the prior 4 years) that was significantly below historical seasonal variation. In addition, this pattern of a dramatic reduction was observed for all levels of triage acuity.[25] A retrospective chart review of children younger than 21 years seen at a pediatric ED from March to June 2020 (compared with the same interval in 2019) noted a 66% decline in ED visits, with significant declines in asthma visits (2% vs 7%; $P < .0001$).[27] A study of in-person asthma encounters at a U.S. tertiary care center in 2020 (compared with 2015 to 2019 historical reference) noted an 87% (outpatient) and 84% (emergency and inpatient) reduction in in-person asthma encounters during the pandemic.[28] However, there has been an increase in respiratory infections this summer and fall. In particular, Australia and the United States have seen a resurgence of cases of respiratory syncytial virus in the late summer, with predicted surges in Canada as well.[29]

In conclusion, studies to date have not demonstrated an increased risk of severe COVID-19 outcomes among children with asthma and have in fact noted a reduction in asthma health care utilization during COVID-19. Although further studies are required, and asthma remains listed as a risk factor in some guidelines, children with asthma appear to not be at increased risk of severe respiratory outcomes compared with children without asthma during the pandemic.

SCHOOL-RELATED ISSUES IN CHILDREN WITH ASTHMA DURING COVID-19

Mask exemptions

Mask wearing, especially indoors, has emerged as a public health measure that significantly reduces transmission of COVID-19 and as a result has been, throughout the pandemic, mandated in schools.[30] There has been significant misinformation that children with asthma should not wear masks because it may impact breathing and lung function. Mask mandates and exemptions have been described as a new frontier for clinicians and are a common request among families of children with asthma.[31]

There is firm evidence that masks do not exacerbate underlying lung conditions.[32,33] A cohort study of 47 infants and young children noted that surgical face masks were not associated with any changes in respiratory parameters nor clinical signs of respiratory distress.[34] A recent scoping review on the impact of masks on cardiorespiratory response to exercise found that, whereas subjective sense of dyspnea may be increased with mask wearing, the objective effects on work of breathing, blood gases, and other physiological parameters are minimal with no sex-based or age-based differences detected.[35] It has been noted by multiple international organizations, including the Canadian Thoracic Society, that there is "NO evidence that wearing a face mask will exacerbate (cause a 'flare up' of) an underlying lung condition.[32] In fact, the opposite may in fact be true. There is emerging evidence that wearing a face mask at school, and in other public places, can reduce spread of other common respiratory infections—such as respiratory syncytial virus and influenza—that are frequent causes of asthma exacerbations and might reduce the risk of viral-triggered asthma exacerbations at school in children.[36] In conclusion, asthma is not an indication for a mask exemption in schools.

School attendance—differentiating asthma/allergic disease from COVID-19

A common frustration during the school year among families of children with asthma and other atopic conditions (in particular rhinitis) is differentiating allergic symptoms from those of COVID-19. This is particularly important to prevent children from missing school unnecessarily. However, unfortunately, differentiating COVID-19 from allergic disease is very difficult to do. The symptoms of COVID-19 can be pleiomorphic and include dramatic loss of taste and smell, gastrointestinal symptoms, and fever/myalgias, and with emerging strains, symptoms may change.[10] However, dry cough and shortness of breath are among the most commonly presenting symptoms of both asthma as well as COVID-19.[37] A study of 435 patients (although not pediatric) who presented for COVID-19 testing at a tertiary medical center noted a high overlap in symptoms of COVID-19 and worsening asthma.[38] In fact, as noted by the American Academy of Allergy, Asthma, and Immunology (AAAAI), it is impossible to distinguish between a viral-induced asthma exacerbation and the symptoms of COVID-19.[39] As a result, anyone symptomatic "should be considered to have COVID-19 until testing proves otherwise."[39]

FIGURE 1. Summary of key points from the article regarding school asthma care during COVID-19.

A modified Delphi process has been used by the ARIA (Allergic Rhinitis and its Impact on Asthma)-EAACI (European Academy of Allergy and Clinical Immunology)-GA^{2}LEN (Global Allergy and Asthma European Network) initiative to establish a set of questions aimed at distinguishing COVID-19 from allergic conditions.[40] However, in the interim, it is very difficult to distinguish these conditions from COVID-19.[37,41] As a result, if there are upper or lower respiratory symptoms, especially if atypical from a child's standard allergic symptoms, COVID-19 testing is the only way to differentiate infection from allergic symptoms including asthma and rhinitis at the present time.

School attendance—virtual learning owing to asthma

Another common question is whether asthma is an indication for virtual learning during the pandemic. As previously described, the evidence to date supports that children with asthma can learn in-person at school because they do not appear to be at increased risk of COVID-19 morbidity or mortality.[37,42] Children in general are less commonly symptomatic with COVID-19 than adults, and those who are symptomatic rarely require hospitalization, although morbidity may vary based on variants.[1,43] Schools are not common vectors of COVID-19 transmission, and child-to-child transmission at schools has been rare, although this may change with variants of concern. A study of Irish notifications of all pediatric COVID-19 cases attending school found no evidence of transmission to other children or adults within the school, as well as a variety of other settings (including music lessons and choir practice).[44] A retrospective study from Germany of school-aged children found child-to-child transmission at schools to be rare (estimated 1 secondary case per roughly 24 infectious school days) and "not the primary cause of SARS-CoV-2 [severe acute respiratory syndrome coronavirus 2] infection in children."[45] A study of nasopharyngeal swabs from 305 adults and pediatric COVID-19 cases in Canada noted that children, compared with adults, were less likely to grow virus in culture and had higher cycle thresholds and lower viral concentrations, "suggesting that children are not the main drivers of SARS-CoV-2 transmission."[46] A study of all school-aged cases of COVID-19 in Australia found only 2 possible cases of secondary school—based transmission (1 in high school, 1 from a staff member to a student) despite close contact with 735 students and 128 school staff.[47] Regarding COVID-19 transmission, as stated in an editorial in *Pediatrics,* "the child is not to blame."[48]

Virtual learning is associated with environmental factors that could worsen asthma control including second-hand smoke exposure, prolonged exposure to indoor aeroallergens, and reduced physical activity.[49,50] There is increasing recognition of the profound impact that remote learning (and its related consequences) has had on children and their families, in particular those facing adverse determinants of health. These include an

impact on school performance including lack of virtual platforms in some homes[51,52]; lack of access to school-based medical programs and lunch programs, which could worsen food insecurity[53]; impact on parental workforce[54,55]; and broad mental health impacts.[56] These adverse social determinants are also more likely to impact those with poorly controlled asthma.[57]

At times, school closures are necessary from a broad public health perspective. However, on an individual level, when schools are open, asthma would not necessarily be an indication for virtual learning unless other considerations are present. In addition, more broadly, it has been identified that " improving monitoring and learning assessment strategies will be critical for educators and policymakers to understand what system adjustments and additional support children will need to overcome the identified gaps in learning, especially for the foundational skills."[58]

School attendance—COVID-19 vaccination

The COVID-19 vaccination provides the first opportunity to reduce the risk of severe COVID-19 outcomes.[59,60] The vaccines are safe, immunogenic, and effective.[59,60] The U.S. Food and Drug Administration (FDA) has provided an emergency use authorization for the Pfizer-BioNTech vaccine in adolescents aged 12 to 15 years, and children aged 5 to 11 years.[61,62] However, broad vaccine hesitancy has been noted in families of adolescents within the United States, with a survey by the CDC noting that only 55.5% of parents/guardians of unvaccinated adolescents would definitely or probably allow their children to receive the COVID-19 vaccine.[63] The CDC has noted that "efforts focusing on communicating the benefits and safety of COVID-19 vaccination for adolescents to the public could help increase adolescent COVID-19 vaccine confidence and vaccination coverage."[63]

As reports of allergic reactions to the mRNA COVID-19 vaccines emerged early in the pandemic, there is a common concern among allergic families, including families of adolescents with asthma, about the risk of an allergic reaction to the COVID-19 vaccine.[64]

Whereas the incidence of anaphylaxis post—COVID-19 vaccines is estimated at approximately 7.91 cases per million doses,[65] which is higher than the historical incidence of vaccine anaphylaxis overall (of 1.3 cases per million doses),[66] this remains an exceptionally rare outcome and, thus far, there has been no long-term morbidity nor mortality associated with COVID-19 vaccine anaphylaxis. Although those who have reported allergic reactions to the COVID-19 vaccine commonly have self-reported prior allergic conditions, these conditions are common in the general population, and the risk is impossible to quantify because the rate of individuals with allergic conditions who have tolerated the COVID-19 vaccine is not available.[65] In addition, as data emerges that revaccination of individuals with an immediate reaction to a previous dose of COVID-19 vaccine is safe,[67-70] and not influenced by testing to the vaccine or its excipients,[71,72] there is increasing recognition these reactions are likely not allergen-driven nor immunoglobulin E—mediated. The CDC's Advisory Committee on Immunization Practices' (ACIP) recommends the use of the COVID-19 vaccine (Pfizer-BioNTech) in adolescents 12 years and older owing to its efficacy against symptomatic COVID-19 disease and to prevent community transmission of SARS-CoV-2[73] including among adolescents with allergic conditions. The only CDC indication for a vaccine exemption currently is a prior severe immediate reaction to a dose of the COVID-19 vaccine or its excipients. Adolescents with asthma and other allergic conditions, in the absence of this history, would not qualify for a vaccine exemption. The Global Initiative for Asthma (GINA) guideline recommends COVID-19 vaccination among those with asthma.[74]

Another common concern is the use of asthma medications such as inhaled corticosteroids (ICS) and biologics, and whether the vaccine can be given while on these medications. Studies have shown the vaccine to be safe and well tolerated even if on asthma biologic therapy or steroid (whether oral or inhaled) therapy, although less data are available for the pediatric population.[62,75] It is recommended that the COVID-19 vaccine and an asthma biologic not be given the same day (to differentiate the inciting agent should a reaction occur).[76] Current asthma medications (with the exception of oral steroid dose of 20 mg or greater prednisone or equivalent per day) are not considered immunosuppressive and are not currently an indication for a booster dose of the COVID-19 vaccine.[77,78]

Vaccine hesitancy has also been described more commonly among those facing other adverse social determinants of health. In a survey study of 2,000 participants evaluating willingness to receive vaccination, attributes associated with a lower willingness to receive vaccination included lack of insurance ($P < .001$), lower educational attainment ($P < .001$), and non-White race.[79,80] These adverse determinants are also associated both with asthma morbidity and COVID-19 risk.[57]

Asthma management

Pharmacological management has an essential role in optimizing asthma control for school-aged children with asthma. The GINA strategy, as well as the AAAAI and multiple other international guidelines, recommend remaining on prescribed asthma medications such as ICS and biologics during the pandemic.[81-86] There is no evidence that these medications increase the risk of COVID-19 infection and, paradoxically, in some studies ICS therapy has been protective against severe outcomes.[26,74] Nebulization should be avoided if possible because it is aerosol generating.[41,87] Influenza vaccination is recommended.[26]

Asthma management during the pandemic must consider a more scoping approach to pediatric health. It is essential to optimize other health conditions that could have a longer-term impact on asthma symptoms and outcomes (and more broad pediatric outcomes) during this time—such as obesity. Studies have documented astounding increases in screen time, reductions in physical activity, and increases in obesity rates among children during the pandemic.[88-90] Obesity has emerged as a factor in children associated with poorer COVID-19 outcomes.[91] In a cross-sectional study of 43,465 children and adolescents, the strongest risk factors for COVID-19 hospitalization included obesity (adjusted risk ratio 3.07; 95% CI: 2.66—3.54).[92] With respect to asthma, obesity increases the sensation of dyspnea, increases airway hyper-responsiveness, impairs immune function, and potentially reduces response to ICS therapy.[93,94] More globally, obesity in childhood increases the risk of a multitude of other health conditions over the course of a lifetime including cardiovascular disease.[95,96]

Asthma management, as with management of all pediatric conditions, must also factor in the impact of adverse social determinants and health disparities. Multiple determinants of health, including housing quality, poverty, health care access,

health literacy, and race and ethnicity, all have an impact on asthma (and COVID-19) outcomes.[50,97-100] At the individual clinician level, and more broadly at the guideline and policy level, steps are required to ensure social determinants are considered in the approach to a family with asthma both during and after the pandemic.

Broadly, the pandemic has also served as a call to resource stewardship and innovation and allowed practitioners to consider how this may impact asthma care moving forward.[101] One such example is step-up or step-down therapy. Whereas remaining on current asthma medications is generally recommended, little guidance exists on how to stratify risk during the pandemic, and little guidance is specific to children or adolescents. For step-down therapy, a stratification based on atopic status, baseline risk, and seasonality has been proposed.[102] With the 2021 return to school, some practitioners are recommending a brief step-up protocol to reduce the autumn risk of asthma exacerbations. Home-based therapy such as home aeroallergen immunotherapy and home omalizumab administration are novel approaches to ongoing provision of medical care during the pandemic, although both have limitations and are only recommended under very specific circumstances.[103,104]

Another example of innovative provision of care is the use of virtual care and telehealth visits, which has emerged as an opportunity to improve access, reduce health disparities, and prevent potential viral exposure in clinical settings during the pandemic.[101] A study of children with asthma residing in 2 remote locations who were offered the choice of an in-person or telemedicine session noted comparable asthma control between the 2 visit types, with high family satisfaction among those who chose the telemedicine encounter.[105] School-based telemedicine interventions have also been studied and are a novel approach to ongoing asthma care especially among underserved families, including those living in remote locations.[106,107] A school-based telemedicine approach would reduce school absence, reduce parental leave, and allow the potential for application of digital health for monitoring exacerbations and adherence to asthma medications.[106,107]

DISCUSSION

There is no evidence that asthma increases the risk of severe COVID-19 outcomes nor that COVID-19 causes severe asthma exacerbations among school-aged children. Asthma is not an indication for a mask exemption nor for a COVID-19 vaccine exemption. It is also not necessarily an indication for consideration of virtual learning. Asthma management consists of remaining on current asthma medications, although step-up or step-down therapy could be considered based on circumstances. More broadly, asthma management during the pandemic must factor in other comorbidities that can worsen asthma control—such as obesity—as well as more broadly the impact of adverse determinants of health. Finally, unprecedented times call for unprecedented change, and this is being seen in the approach to home-based and virtual care.

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